Queen's University Environmental Science and Technology Research Centre (QUESTOR)

The Queen's University of Belfast, Northern Ireland

Researchers supported by industry partners are looking at the basic science underlying improved methods of effluent treatment, clean technology, life cycle assessment, modelling, and environmental communications.

A National Science Foundation-Linked Industry/ University Cooperative Research Center since 1990

Centre Mission and Rationale

The QUESTOR Centre is an industry/university co-operative research centre carrying out fundamental and strategic, integrated, multidisciplinary scientific research in selected critical aspects of environmental science and technology. The research programmes seek to provide understanding aimed at finding cost-effective solutions to environmental problems allied to encouraging industrial endeavour and minimising environmental impact.

Automated thermal desorber linked to bench-top mass spectrometer for the analysis of volatile emissions

Results of the Centre's research should:

- Help to set the agenda for research into the basic science underlying effluent treatment and clean technology processes, thereby leading to more environmentally friendly production
- Improve technology transfer between the University and the industrial members
- Identify and train promising post-graduates and post-doctoral scientists and engineers for employment in industry.

Research Programme

The Centre's research is interdisciplinary. Research projects are carried out in the Departments of Agricultural Chemistry, Chemical Engineering, Chemistry, Civil Engineering, Computer Science, Microbiology, and Psychology. Research carried out by the post-graduate students and post-doctoral staff is supervised by academic staff in the various departments.

The main focus of the research programme is on techniques for effluent clean-up and clean technology. Research on the application of parallel processing to air and water modelling is also being undertaken, as are studies on the defects in environmental communications between experts and the public and the applications of life cycle assessment. A wide range of projects are being funded in the Centre's six research areas —

- ***Adsorption.*** Studies are under way on the effectiveness of the natural materials peat and lignite and their derived activated carbons for the removal of heavy metals and organics such as dyes and pesticides. Removal of odours using microbes supported on peat and lignite is also being studied. Initial results on the effectiveness of these low-cost materials are promising.
- ***Clean Technology.*** Research is under way or planned for clean organic, inorganic, and microbial synthesis to reduce pollution arising from waste products.
- ***Communications.*** Methods are being sought to detect and repair the breakdown in communications between the expert and the layman on environmental matters.
- ***Flocculation.*** Research here concentrates on understanding the mechanism of formation of flocs

Bench-top rig for the study of flocculation using iron and aluminum salts

Work in the Questor anaerobic cabinet on *R.Rhodochrous* NCIMB 13064 for the degradation of chlorinated alkanes

using aluminum, iron, and mixed iron/aluminum reagents. Electron microscope and atomic force microscope studies have revealed important details of the formation of the floc, which should lead to more stable flocs. Work is being carried out on a pilot plant flowing-flocculation system.

- ***Microbial Degradation.*** Research into the biochemistry, genetics, and physiology of anaerobic microorganisms such as *Rhodococcus* is under way. Degradation of chlorinated alkanes, polycyclic aromatics, and compounds with the carbon-phosphorus bond is being studied by two groups.
- ***Parallel Processing.*** Applications of parallel processors to existing air and three-dimensional water models have shown speed improvements of up to a factor of ten. Current work aims to give a similar improvement for modelling of contaminants in the vadose zone and also modelling of odours.

Special Features

The QUESTOR Centre was the first environmental centre outside the United States to use the National Science Foundation (NSF) model for industry/university cooperative environmental research. As a non-U.S. centre, QUESTOR is unique in having an NSF Centre evaluator.

The Centre funds a mix of post-graduates working towards PhDs and post-docs carrying out research. This mix is very valuable to the students, who learn from the post-docs. In addition, it is found that a PhD carried out in collaboration with industry, with well-defined goals to be met, is a highly valuable training mode and better prepares the student to enter industry.

International links are very important. Joint research is being carried out with the Hazardous Substance Management Research Center (HSMRC) in New Jersey and the Institute of Biochemistry and Physiology of Microorganisms at Pushchino, Russia. Links are also in place with RECORD in France and formative centres in Canada and Germany.

The existence of the Centre has greatly increased the interactions between the University and industry. It has also brought into the University state-of-the-art equipment which would not otherwise be available. This means that students can be exposed to modern equipment before leaving the University. The Centre has the only tandem mass spectrometer in Ireland and the only ICP-mass spectrometer in Northern Ireland. Other equipment includes a high-resolution mass spectrometer, a porosimeter, a capillary zone electrophoresis instrument, a thermal analyser, an ion chromatograph, an HPLC, a GC-FTIR, and computer-controlled fermentation vessels.

Rig for the comparison of adsorption properties of various absorbers

Pump-priming funding for the QUESTOR Centre came from the International Fund for Ireland, administered along the lines of an NSF Centre grant by the Northern Ireland Industrial Research and Technology Unit. Additional funding came from the European Community STRIDE programme for developing the infrastructure for R&D in Northern Ireland. Most recently the Centre received £2.74 million from the European Union-funded TDP programme, the successor to the STRIDE programme. This funding will build the clean technology side of the research programme and also install a major demonstration facility which will be used to show current remediation and clean technologies to members and also industry in general throughout Ireland. In addition, the International Fund for Ireland has made a further grant of £1.06 million to the Centre to develop an outreach programme to facilitate environmental technology transfer to industry throughout Ireland, paying particular attention to small and medium- sized enterprises. Industry contributions to the Centre come from its members, which range from manufacturers of pharmaceuticals, chemicals, instruments, textiles, and beverages through suppliers of electricity and water. The Department of the Environment for Northern Ireland is also a member.

The Centre was a winner in the prestigious UK-wide competition, “The Queen’s Anniversary Prizes for Higher and Further Education” for 1996.

A highly successful conference entitled “Hazardous Waste Management - The Incineration Option” was held in September 1992, at which industry and government regulators and planners achieved a much greater appreciation of the other’s point of view. Regular workshops between the QUESTOR academics and industry members are held to discuss the research strategy of the Centre.

Each summer a number of second-year undergraduates are employed to work in the Centre, where they gain experience in employment and a better understanding of the requirements of industry. A programme to involve primary school teachers is currently being planned to counteract the worrying trend of many students to turn away from science and engineering.

The Questor tandem mass spectrometer in the foreground with the Questor ICP-mass spectrometer in the background

---

Center Headquarters

Centre Director: Prof. Jim Swindall
The QUESTOR Centre,
The Queen’s University of Belfast,
David Keir Building
Stranmillis Road,
Belfast BT9 5AG
Northern Ireland
Phone: +44 (1232) 335577/8
Fax: +44 (1232) 661462
E-mail: j.swindall@qub.ac.uk

Centre Evaluator: Dr S. George Walters
789 Sergeantsville Road
Stockton, NJ 08559
Phone: (609) 397-0990
Fax: (609) 397-0990

NSF 93-97tt (rev. 7/96)